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Editorial

Battery powered angioplasty

The principle of balloon angioplasty—dilatation of stenosed arteries by nothing but pressure—is so simple that doctors and patients find it quite logical. But in our high-tech environment, where lost door keys answer to a whistle and pacemakers make their own decisions and respond to questions, balloon angioplasty may appear too simple to be taken seriously. The inflation of a fluid filled angioplasty balloon with the help of an ordinary syringe does not produce noise and is often not even recognised by the somewhat distracted cath lab personnel, who are supposed to record the duration of the inflations. In contrast battery powered angioplasty makes itself known by smart looking, thoughtfully engineered electric motors with a disposable energy supply that generate a distinct noise which tells everybody nearby (including the patient) that something important is happening.

In this issue of the *British Heart Journal* two types of battery powered angioplasty are analysed by workers who used these instruments hoping to overcome some unresolved problems with percutaneous transluminal coronary angioplasty (PTCA). The paper by Anderson and Ward deals with what has been termed "slow rotational angioplasty"[1] whereas Serruys *et al* describe their initial experience with so-called "directional atherectomy".[2] Both methods use battery powered electric engines (completely disposable for directional atherectomy and reusable but more expensive for rotational angioplasty) to turn a thin drive shaft that runs through the entire length of the catheter and rotates either a blunt tip at the end or a cylindrical knife passing over a side opening. The targets are chronic occlusions (for the turning blunt tip) and atheromatous plaques (for the cutting knife). Both instruments are bulky, not cheap, and require special training for their user. The fact that they are fairly rigid and have a larger diameter than angioplasty balloons makes them potentially offensive weapons. So it seems quite legitimate to undertake a critical analysis of their merits and disadvantages, in order to decide whether such techniques are justified.

Directional atherectomy

When Simpson, an innovative angioplasty pioneer, designed his instrument he had in mind to remove the *corpus delicti* from the coronary (and peripheral) artery, hoping to reduce acute and chronic problems inherent in balloon angioplasty.[3] He was right as far as the acute problems were concerned[4] but not quite right about the chronic problems.[5] Directional atherectomy rarely produces abrupt closure of the artery, probably because its mode of action avoids the stretching and splitting of plaques and the subsequent creation of intimal plaques and dissections. The sharp, rotating knife creates a smooth cut without the customary fissures and cracks; but the stiff housing itself (despite the semiflexible distal collecting chamber) may damage the artery, in particular where there are bends to be negotiated. Experience has shown that this may account for some of the acute problems. The case of detachment (and, fortunately, successful retrieval) of the tissue container at the tip of the device described in the current issue is unique. The attachment of the container has since been altered.

For many indications the long term outcome after atherectomy has not matched initial expectations. Surprisingly, the open wound left after transluminal plaque removal is as good a basis for restenosis as the compressed and split plaque. If you take into account the relatively large vessel size of most target vessels submitted to this procedure the overall restenosis rate after atherectomy of primary lesions (23%) is not much lower than that after PTCA alone.[6] In patients who have had previous angioplasty at the same site, this figure is higher and becomes 53% for the third attempt, and when the lesion was located in the mid portion of a vein bypass graft restenosis was seen in 61%.[7]

Why is this so? Presumably there are several reasons. Even clean cuts do not produce clean vessels. Flow in normal vessels is laminar, whereas after atherectomy it is likely to be turbulent—an important risk factor for restenosis. Secondly, the deep vascular injury (up to 70% atherectomy specimens contain media and 30% contain adventitia[8 9]) may trigger an exuberant repair process. Intuitively, atherectomy would seem to lend itself beautifully to the removal of very eccentric localised lesions that can be excised with one or two precise, clean cuts. Indeed, if such cases are singled out the restenosis rate is very low and compares favourably with all other existing transluminal techniques.[10] In such patients the use of the larger guiding catheter, with its inherent problems, is certainly justified.

On page 122 Serruys *et al* report encouraging results after directional atherectomy.[2] The angiographically determined luminal diameter after this procedure was consistently better than would have been expected after balloon angioplasty. This is not surprising. In practice it should be possible to sculpture the artery to any desired result by removing as much material as is prudent. The issue therefore is not the potential for plaque removal but rather the right moment to stop before cutting through the adventitia. On the other hand, there is little correlation between the diameter stenosis after angioplasty and long term outcome. The Rotterdam data suggest a 77% uneventful six month follow up, but no angiographic data are presented. Thus the long term consequences of the promising initial outcome have yet to be demonstrated and compared with other techniques.

Other atherectomy devices

Another battery powered angioplasty device has been introduced by Stack; it is called the transluminal extraction cathether (TEC) and it aspirates the debris that the conical cutter, which is mounted at the tip of a shaft revolving at 750 rpm, produces when cutting forward through atheromatous plaques.[11] This instrument has shown its merits in extremely friable and diffusely diseased vessels where the aspiration of mobilised atheromatous material prevents downstream embolisation.[12] It does not allow, however, precise "sculpturing" of vessels and the mean residual diameter stenosis was 30%[13]; there is a relatively high overall restenosis rate of more than 40%.[13]

The "rotablator", launched by Auth and colleagues,[14,15] uses compressed air (not batteries) to drive it at 160 000–190 000 rpm; it resembles a dental drill and creates small particles, most of which do not seem to be trapped in the capillary bed.[16,17] It may be useful in very hard, subtotal non-dilatable lesions; restenosis is frequent.[18] As is the case with the TEC device, it can only create channels—admittedly smooth and round—as large as the instrument itself.

Slow rotational angioplasty

The rationale behind this technique, which was first described by Kaltenbach (another angioplasty pioneer) and Vallbracht in 1987,[19] was the assumption that a larger and rounder tip was less likely to cause dissections during recanalisation of totally occluded arteries and that a slowly turning blunt tip would find its way through total occlusions more easily. Thus a device resembling a magnum wire was created; this is rotated at a speed of up to 200 rpm by a small motor.

Apart from the reports of Kaltenbach and Vallbracht[20-22] there are few studies of slow rotational angioplasty. Kaltenbach and Vallbracht claimed a success rate of some 65% in recanalising old chronic occlusions.[23] With a preliminary re-angiography rate of 81% they found that 38% of the successful cases were improved at four months, 33% had significant restenosis, and 28% had reoccluded.[23] To achieve recanalisation of chronic occlusions it is vital to select patients with a stump that guides the catheter towards the correct lumen. Those who used the appropriate patient selection criteria reported similar results with balloon angioplasty alone; however, the use of the magnum wire technique has certainly helped to obtain these results more easily. These different techniques have not been widely evaluated; there is only one study comparing the magnum wire technique with the conventional balloon angioplasty technique, and that was performed by the group which devised the magnum wire.[24]

Slow rotational angioplasty is not radically different from mechanical recanalisation with other devices. There is certainly an added risk when an operator uses instruments that reduce "feel", as does slow rotational angioplasty. The risks of the method are clearly shown in the paper by Anderson and Ward on page 130.[1] We should be cautious, not only about the use of this device but also about the potential risk of supposedly harmless attempts at recanalising chronically occluded coronary arteries.[25] Operators attempting this should use a familiar instrument that allows optimal tactile feedback rather than an engine driven shaft.

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